Appendix A Symbols and their Meanings TCC
This module defines symbols used throughout the Collaborative Statistics textbook.

Chapter (1st used)	Symbol	Spoken	Meaning
Sampling and Data	$\sqrt{}$	The square root of	same
Sampling and Data	π	Pi	3.14159… (a specific number)
Descriptive Statistics	Q1	Quartile one	the first quartile
Descriptive Statistics	Q2	Quartile two	the second quartile
Descriptive Statistics	Q3	Quartile three	the third quartile
Descriptive Statistics	IQR	inter-quartile range	Q3-Q1=IQR
Descriptive Statistics	x	x-bar	sample mean
Descriptive Statistics	μ	mu	population mean

Chapter (1st used)	Symbol	Spoken	Meaning
Descriptive Statistics	$s\ s_x\ \text{sx}$	s	sample standard deviation
Descriptive Statistics	$s^2\ s_x^2$	s-squared	sample variance
Descriptive Statistics	$\sigma\ \sigma_x\ \text{σx}$	sigma	population standard deviation
Descriptive Statistics	$\sigma^2\ \sigma_x^2$	sigma-squared	population variance
Descriptive Statistics	Σ	capital sigma	sum
Probability Topics	$\{\}$	brackets	set notation
Probability Topics	S	S	sample space
Probability Topics	A	Event A	event A
Probability Topics	$P(A)$	probability of A	probability of A occurring

Chapter (1st used)	Symbol	Spoken	Meaning
Probability Topics	$P(A \mid B)$	probability of A given B	prob. of A occurring given B has occurred
Probability Topics	$P(A \, \text{or} \, B)$	prob. of A or B	prob. of A or B or both occurring
Probability Topics	$P(A \, \text{and} \, B)$	prob. of A and B	prob. of both A and B occurring (same time)
Probability Topics	A'	A-prime, complement of A	complement of A, not A
Probability Topics	$P(\text{A'})$	prob. of complement of A	same
Probability Topics	G_1	green on first pick	same
Probability Topics	$P(G_1)$	prob. of green on first pick	same
Discrete Random Variables	PDF	prob. distribution function	same

Chapter (1st used)	Symbol	Spoken	Meaning
Discrete Random Variables	X	X	the random variable X
Discrete Random Variables	X~	the distribution of X	same
Discrete Random Variables	B	binomial distribution	same
Discrete Random Variables	G	geometric distribution	same
Discrete Random Variables	H	hypergeometric dist.	same
Discrete Random Variables	P	Poisson dist.	same
Discrete Random Variables	λ	Lambda	average of Poisson distribution
Discrete Random Variables	$\geq$	greater than or equal to	same

Chapter (1st used)	Symbol	Spoken	Meaning
Discrete Random Variables	$\leq$	less than or equal to	same
Discrete Random Variables	$=$	equal to	same
Discrete Random Variables	$\neq$	not equal to	same
Continuous Random Variables	$f(x)$	f of x	function of x
Continuous Random Variables	pdf	prob. density function	same
Continuous Random Variables	U	uniform distribution	same
Continuous Random Variables	Exp	exponential distribution	same
Continuous Random Variables	k	k	critical value

Chapter (1st used)	Symbol	Spoken	Meaning
Continuous Random Variables	$f(x) =$	f of x equals	same
Continuous Random Variables	m	m	decay rate (for exp. dist.)
The Normal Distribution	N	normal distribution	same
The Normal Distribution	z	z-score	same
The Normal Distribution	Z	standard normal dist.	same
The Central Limit Theorem	CLT	Central Limit Theorem	same
The Central Limit Theorem	X	X-bar	the random variable X-bar
The Central Limit Theorem	μ_x	mean of X	the average of X
The Central Limit Theorem	μ_x	mean of X-bar	the average of X-bar

Chapter (1st used)	Symbol	Spoken	Meaning
The Central Limit Theorem	σ_x	standard deviation of X	same
The Central Limit Theorem	σ_x	standard deviation of X-bar	same
The Central Limit Theorem	ΣX	sum of X	same
The Central Limit Theorem	Σx	sum of x	same
Confidence Intervals	CL	confidence level	same
Confidence Intervals	CI	confidence interval	same
Confidence Intervals	EBM	error bound for a mean	same
Confidence Intervals	EBP	error bound for a proportion	same
Confidence Intervals	t	student-t distribution	same
Confidence Intervals	df	degrees of freedom	same

Chapter (1st used)	Symbol	Spoken	Meaning
Confidence Intervals	$t_{\frac{\alpha}{2}}$	student-t with a/2 area in right tail	same
Confidence Intervals	p' $\widehat{p}$	p-prime; p-hat	sample proportion of success
Confidence Intervals	q' $\hat{q}$	q-prime; q-hat	sample proportion of failure
Hypothesis Testing	H_0	H-naught, H-sub 0	null hypothesis
Hypothesis Testing	H_a	H-a, H-sub a	alternate hypothesis
Hypothesis Testing	H_1	H-1, H-sub 1	alternate hypothesis
Hypothesis Testing	α	alpha	probability of Type I error
Hypothesis Testing	β	beta	probability of Type II error
Hypothesis Testing	$\overline{X} - \overline{X}$	X1-bar minus X2-bar	difference in sample means

Chapter (1st used)	Symbol	Spoken	Meaning
	$\mu_1 - \mu_2$	mu-1 minus mu-2	difference in population means
	$P_1 - P_2$	P1-prime minus P2-prime	difference in sample proportions
	$p_1 - p_2$	p1 minus p2	difference in population proportions
Chi-Square Distribution	X^2	Ky-square	Chi-square
	O	Observed	Observed frequency
	E	Expected	Expected frequency
Linear Regression and Correlation	$y = a + \mathrm{b}x$	y equals a plus b-x	equation of a line
	$\hat{y}$	y-hat	estimated value of y
	r	correlation coefficient	same

Chapter (1st used)	Symbol	Spoken	Meaning
	ε	error	same
	SSE	Sum of Squared Errors	same
	$1.9s$	1.9 times s	cut-off value for outliers
F-Distribution and ANOVA	F	F-ratio	F ratio

Symbols and their Meanings

Appendix B Formulas TCC
This module provides an overview of Statistics Formulas used as a part of
Collaborative Statistics collection (col10522) by Barbara Illowsky and
Susan Dean.

Formula
Factorial

$$n! = n(n-1)(n-2)\ldots(1)$$

$$0! = 1$$

Formula
Combinations

$$\binom{n}{r} = \frac{n!}{(n-r)!r!}$$

Formula
Binomial Distribution

$$X \sim B(n, p)$$

$$P(X = x) = \binom{n}{x}p^x q^{n-x} \text{ , for } x = 0, 1, 2, \ldots, n$$

Formula
Geometric Distribution

$$X \sim G(p)$$

$$P(X = x) = q^{x-1}p \text{ , for } x = 1, 2, 3, \ldots$$

Formula
Hypergeometric Distribution

$$X \sim H(r, b, n)$$

$$P\left(X = x\right) = \left(\frac{\binom{r}{x}\binom{b}{n-x}}{\binom{r+b}{n}}\right)$$

Formula
Poisson Distribution

$$X \sim P(\mu)$$

$$P\left(X = x\right) = \frac{\mu^x e^{-\mu}}{x!}$$

Formula
Uniform Distribution

$$X \sim U(a, b)$$

$$f(X) = \frac{1}{b-a}, a < x < b$$

Formula
Exponential Distribution

$$X \sim \text{Exp}(m)$$

$$f(x) = me^{-mx}, m > 0, x \geq 0$$

Formula
Normal Distribution

$$X \sim N\left(\mu, \sigma^2\right)$$

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}}, \quad -\infty < x < \infty$$

Formula
Gamma Function

$$\Gamma(z) = \int_0^\infty x^{z-1} e^{-x} \, \mathrm{dx} \; z >$$

$$\Gamma\left(\tfrac{1}{2}\right) = \sqrt{\pi}$$

$\Gamma(m + 1) = m!$ for m, a nonnegative integer

otherwise: $\Gamma(a + 1) = a\Gamma(a)$

Formula
Student-t Distribution

$$X \sim t_{\text{df}}$$

$$f\left(x\right) = \frac{\left(1+\frac{x^2}{n}\right)^{\frac{-(n+1)}{2}}\Gamma\left(\frac{n+1}{2}\right)}{\sqrt{n\pi}\,\Gamma\left(\frac{n}{2}\right)}$$

$$X = \frac{Z}{\sqrt{\frac{Y}{n}}}$$

$Z \sim N(0,1)$, $Y \sim X^2_{\text{df}}$, n = degrees of freedom

Formula

Chi-Square Distribution

$$X \sim X^2_{\text{df}}$$

$$f\left(x\right) = \frac{x^{\frac{n-2}{2}}e^{\frac{-x}{2}}}{2^{\frac{n}{2}}\Gamma\left(\frac{n}{2}\right)}, \; x > \quad , n = \text{positive integer and degrees of freedom}$$

Formula

F Distribution

$$X \sim F_{\text{df}(n),\text{df}(d)}$$

$\text{df}(n) =$ degrees of freedom for the numerator

$\text{df}(d) =$ degrees of freedom for the denominator

$$f\left(x\right) = \frac{\Gamma\left(\frac{u+v}{2}\right)}{\Gamma\left(\frac{u}{2}\right)\Gamma\left(\frac{v}{2}\right)}\left(\frac{u}{v}\right)^{\frac{u}{2}}x^{\left(\frac{u}{2}-1\right)}\left[1+\left(\frac{u}{v}\right)x\right]^{-.5(u+v)}$$

$$X = \frac{Y_u}{W_v} \;, Y, W \text{ are chi-square}$$

Appendix C Notes for the TI-83, 83+, 84 Calculator TCC
Notes and tips for using TI-83, TI-83+, and TI-84 calculators for statistics applications.

Quick Tips

Legend

- ▢

  represents a button press
- [   ] represents yellow command or green letter behind a key
- <   > represents items on the screen

To adjust the contrast
Press

2nd

, then hold

▲

to increase the contrast or

▼

to decrease the contrast.

To capitalize letters and words
Press

ALPHA

to get one capital letter, or press

2nd

, then

ALPHA

to set all button presses to capital letters. You can return to the top-level button values by pressing

ALPHA

again.

To correct a mistake
If you hit a wrong button, just hit

CLEAR

and start again.

To write in scientific notation
Numbers in scientific notation are expressed on the TI-83, 83+, and 84 using E notation, such that...

- 4.321 E 4 = 4.321×10^{4}
- 4.321 E -4 = 4.321×10^{-4}

To transfer programs or equations from one calculator to another:
Both calculators: Insert your respective end of the link cable cable and press

2nd

, then `[LINK]`.
Calculator receiving information:

Use the arrows to navigate to and select `<RECEIVE>`
Press
ENTER

Calculator sending information:

Press appropriate number or letter.

Use up and down arrows to access the appropriate item.
Press   to select item to transfer.
ENTER

Press right arrow to navigate to and select<TRANSMIT>.
Press
ENTER

> **Note:**ERROR 35 LINK generally means that the cables have not been inserted far enough.

Both calculators: Insert your respective end of the link cable cable Both calculators: press

2nd

, then [QUIT] To exit when done.

Manipulating One-Variable Statistics

> **Note:**These directions are for entering data with the built-in statistical program.

Data	Frequency
-2	10

Data	Frequency
-1	3
0	4
1	5
3	8

Sample DataWe are manipulating 1-variable statistics.

To begin:

Turn on the calculator.

ON

Access statistics mode.

STAT

Select`<4:ClrList>`to clear data from lists, if desired.

4

,

ENTER

Enter list`[L1]`to be cleared.

2nd

, `[L1]` ,

ENTER

Display last instruction.

2nd

, [ENTRY]

Continue clearing remaining lists in the same fashion, if desired.

◀

,

2nd

, [L2] ,

ENTER

Access statistics mode.

STAT

Select <1:Edit . . .>

ENTER

Enter [L1]. (You may [L1])
data. Data   need to
values go   arrow over
into   to

o Type in a data value and enter it.
   (For negative numbers, use the
   negate (-) key at the bottom of the
   keypad)

(−)

,

9

,

ENTER

- Continue in the same manner until all data values are entered.

In [L2], enter the frequencies for each data value in [L1].

- Type in a frequency and enter it. (If a data value appears only once, the frequency is "1")

4

,

ENTER

- Continue in the same manner until all data values are entered.

Access statistics mode.

STAT

Navigate to <CALC>
Access <1:1-var Stats>

ENTER

Indicate that the data is in [L1]...

2nd

, [L1] ,

,

...and indicate that the frequencies are in **[L2]**.

2nd

, **[L2]** **,**

ENTER

The statistics should be displayed. You may arrow down to get remaining statistics. Repeat as necessary.

Drawing Histograms

Note: We will assume that the data is already entered

We will construct 2 histograms with the built-in STATPLOT application. The first way will use the default ZOOM. The second way will involve customizing a new graph.

Access graphing mode.

2nd

, **[STAT PLOT]**

Select **<1:plot 1>** To access plotting - first graph.

ENTER

Use the arrows navigate go to **<ON>** to turn on Plot 1.

<ON> .

`,` **ENTER**

Use the arrows to go to the histogram picture and select the histogram. **ENTER**

Use the arrows to navigate to `<Xlist>`
If "L1" is not selected, select it.

2nd

`,` `[L1]` `,`

ENTER

Use the arrows to navigate to `<Freq>`.
Assign the frequencies to `[L2]`.

2nd

`,` `[L2]` `,`

ENTER

Go back to access other graphs.

2nd

`,` `[STAT PLOT]`

Use the arrows to turn off the remaining plots.
Be sure to deselect or clear all equations before graphing.

To deselect equations:

Access the list of equations.

Y=

Select each equal sign (=).

▼

▶

ENTER

Continue, until all equations are deselected.

To clear equations:

Access the list of equations.

Y=

Use the arrow keys to navigate to the right of each equal sign (=) and clear them.

▼

▶

CLEAR

Repeat until all equations are deleted.

To draw default histogram:

Access the ZOOM menu.

ZOOM

Select<9:ZoomStat>

9

The histogram will show with a window automatically set.

To draw custom histogram:

Access _____ to set the graph parameters.
WINDOW

- $X_{min} = -2.5$
- $X_{max} = 3.5$
- $X_{scl} = 1$ (width of bars)
- $Y_{min} = 0$
- $Y_{max} = 10$
- $Y_{scl} = 1$ (spacing of tick marks on y-axis)
- $X_{res} = 1$

Access _____ to see the histogram.
GRAPH

To draw box plots:

Access graphing mode.

2nd

, [STAT PLOT]

Select <1:Plot 1> to access the first graph.

ENTER

Use the arrows to select <ON> and turn on Plot 1.

ENTER

Use the arrows to select the box plot picture and enable it.

ENTER

Use the arrows to navigate to `<Xlist>`
If "L1" is not selected, select it.

`2nd`

`, [L1] ,`

`ENTER`

Use the arrows to navigate to `<Freq>`.
Indicate that the frequencies are in `[L2]`.

`2nd`

`, [L2] ,`

`ENTER`

Go back to access other graphs.

`2nd`

`, [STAT PLOT]`

Be sure to deselect or clear all equations before graphing using the method mentioned above.
View the box plot.

`GRAPH`

`, [STAT PLOT]`

Linear Regression

Sample Data

The following data is real. The percent of declared ethnic minority students at De Anza College for selected years from 1970 - 1995 was:

Year	Student Ethnic Minority Percentage
1970	14.13
1973	12.27
1976	14.08
1979	18.16
1982	27.64
1983	28.72
1986	31.86
1989	33.14
1992	45.37
1995	53.1

The independent variable is "Year," while the independent variable is "Student Ethnic Minority Percent."

Student Ethnic Minority Percentage
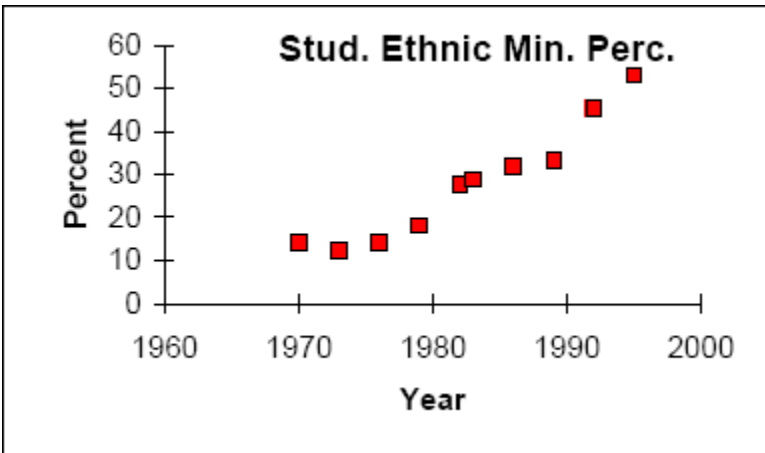
By hand, verify the scatterplot above.

Note: The TI-83 has a built-in linear regression feature, which allows the data to be edited. The x-values will be in

`[L1]`

; the y-values in

`[L2]`

.

To enter data and do linear regression:

ON Turns calculator on

`ON`

Before accessing this program, be sure to turn off all plots.

- Access graphing mode

mode.

2nd

, [STAT PLOT]
- Turn off all plots.

4

,

ENTER

Round to 3 decimal places. To do so:

- Access the mode menu.

MODE

, [STAT PLOT]
- Navigate to <Float> and then to the right to <3>.

▼

▶

- All numbers will be rounded to 3 decimal places until changed.

ENTER

Enter statistics mode and clear lists [L1] and [L2], as describe above.

STAT

,

4
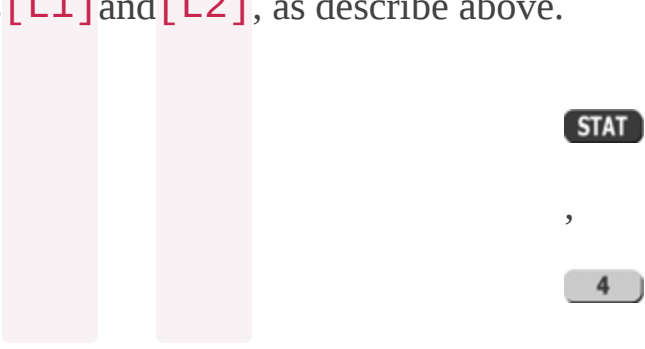
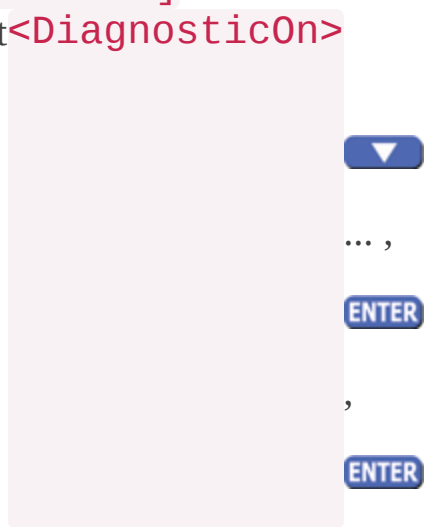Enter editing mode to insert values for x and y.

STAT

,
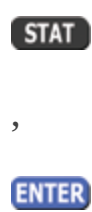
ENTER

Enter each value. Press ENTER to continue.

To display the correlation coefficient:

Access the catalog.

2nd

, [CATALOG]

Arrow down and select <DiagnosticOn>

▼

... ,

ENTER

,

ENTER

^{r}andr^2will be displayed during regression calculations.
Access linear regression.

STAT

▶

Select the form of$y = a + bx$

8

,

ENTER

The display will show:
LinReg

- $y = a + bx$
- $a = -3176.909$
- $b = 1.617$
- $r^2 = 0.924$
- $r = 0.961$

This means the Line of Best Fit (Least Squares Line) is:

- $y = -3176.909 + 1.617x$
- $\text{Percent} = -3176.909 + 1.617(\text{year \#})$

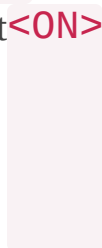The correlation coefficient $r = 0.961$
To see the scatter plot:

Access graphing mode.

2nd

, [STAT PLOT]

Select `<1:plot 1>` To access plotting - first graph.

`ENTER`

Navigate and select `<ON>` to turn on Plot 1.

`<ON>`

`ENTER`
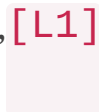
Navigate to the first picture.
Select the scatter plot.

`ENTER`

Navigate to `<Xlist>`
If `[L1]` is not selected, press `2nd` , `[L1]` to select it.
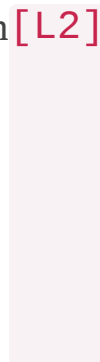
Confirm that the data values are in `[L1]`.

`<ON>`

`ENTER`

Navigate to `<Ylist>`
Select that the frequencies are in `[L2]`.

`2nd`

, `[L2]` ,

`ENTER`

Go back to access other graphs.

`2nd`

`[STAT PLOT]`

, [STAT PLOT]

Use the arrows to turn off the remaining plots.

Access ⬛**WINDOW** to set the graph parameters.

- $X_{\min} = 1970$
- $X_{\max} = 2000$
- $X_{\text{scl}} = 10$ (spacing of tick marks on x-axis)
- $Y_{\min} = -0.05$
- $Y_{\max} = 60$
- $Y_{\text{scl}} = 10$ (spacing of tick marks on y-axis)
- $X_{\text{res}} = 1$

Be sure to deselect or clear all equations before graphing, using the instructions above.

Press ⬛**GRAPH** to see the scatter plot.

To see the regression graph:

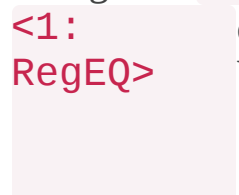Access the equation menu. The regression equation will be put into Y1.

⬛**Y=**

Access the vars menu and navigate to <5: Statistics>

⬛**VARS**

,

⬛**5**

Navigate to <EQ>.

<1: RegEQ> contains the regression equation which will be entered in Y1.

⬛**ENTER**

Press GRAPH . The regression line will be superimposed over scatter plot.

To see the residuals and use them to calculate the critical point for an outlier:

Access the list. RESID will be an item on the menu.
Navigate to it.

2nd

, [LIST],
<RESID>

Confirm twice to view the list of residuals. Use the arrows to select them.

ENTER

,

ENTER

The critical point for an outlier is: $1.9V \frac{\text{SSE}}{n-2}$ where:

- n = number of pairs of data
- SSE = sum of the squared errors
- $\sum \text{residual}^2$

Store the residuals in [L3].

STO►

,

2nd

, [L3],

ENTER

Calculate the $\frac{(\text{residual})^2}{n-2}$. Note that $n - 2 = 8$

2nd

, [L3] ,

x²

,

÷

,

8

Store this value in [L4].

STO▶

,

2nd

, [L4] ,

ENTER

Calculate the critical value using the equation above.

1

,

.

,

9

,

[X]

,

[2nd]

, [V] ,

[2nd]

, [LIST]

[▶]

,

[▶]

,

[5]

,

[2nd]

, [L4] ,

[)]

,

[)]

,

[ENTER]

Verify that the calculator displays: 7.642669563. This is the critical value.

Compare the absolute value of each residual value in `[L3]` to 7.64 . If the absolute value is greater than 7.64, then the (x, y) corresponding point is an outlier. In this case, none of the points is an outlier.

To obtain estimates of y for various x-values:
There are various ways to determine estimates for "y". One way is to substitute values for "x" in the equation. Another way is to use the

TRACE

on the graph of the regression line.

TI-83, 83+, 84 instructions for distributions and tests

Distributions

Access `DISTR` (for "Distributions").

For technical assistance, visit the Texas Instruments website at http://www.ti.com and enter your calculator model into the "search" box.

Binomial Distribution

- `binompdf(n,p,x)` corresponds to P(X = x)
- `binomcdf(n,p,x)` corresponds to P(X ≤ x)
- To see a list of all probabilities for x: 0, 1, . . . , n, leave off the "`x`" parameter.

Poisson Distribution

- `poissonpdf(λ,x)` corresponds to P(X = x)
- `poissoncdf(λ,x)` corresponds to P(X ≤ x)

Continuous Distributions (general)

- $-\infty$ uses the value -1EE99 for left bound
- ∞ uses the value 1EE99 for right bound

Normal Distribution

- `normalpdf(x,μ,σ)` yields a probability density function value (only useful to plot the normal curve, in which case "`x`" is the variable)
- `normalcdf(left bound, right bound, μ,σ)` corresponds to P(left bound < X < right bound)
- `normalcdf(left bound, right bound)` corresponds to P(left bound < Z < right bound) - standard normal
- `invNorm(p,μ,σ)` yields the critical value, k: P(X < k) = p
- `invNorm(p)` yields the critical value, k: P(Z < k) = p for the standard normal

Student-t Distribution

- `tpdf(x,df)` yields the probability density function value (only useful to plot the student-t curve, in which case "`x`" is the variable)
- `tcdf(left bound, right bound, df)` corresponds to P(left bound < t < right bound)

Chi-square Distribution

- `X²pdf(x,df)` yields the probability density function value (only useful to plot the chi^2 curve, in which case "`x`" is the variable)
- `X²cdf(left bound, right bound, df)` corresponds to P(left bound < X^2 < right bound)

F Distribution

- `Fpdf(x,dfnum,dfdenom)` yields the probability density function value (only useful to plot the F curve, in which case "`x`" is the variable)
- `Fcdf(left bound,right bound,dfnum,dfdenom)` corresponds to P(left bound < F < right bound)

Tests and Confidence Intervals

Access `STAT` and `TESTS`.

For the Confidence Intervals and Hypothesis Tests, you may enter the data into the appropriate lists and press `DATA` to have the calculator find the sample means and standard deviations. Or, you may enter the sample means and sample standard deviations directly by pressing `STAT` once in the appropriate tests.

Confidence Intervals

- `ZInterval` is the confidence interval for mean when σ is known
- `TInterval` is the confidence interval for mean when σ is unknown; s estimates σ.
- `1-PropZInt` is the confidence interval for proportion

Note: The confidence levels should be given as percents (ex. enter `"95"` or `".95"` for a 95% confidence level).

Hypothesis Tests

- `Z-Test` is the hypothesis test for single mean when σ is known
- `T-Test` is the hypothesis test for single mean when σ is unknown; s estimates σ.
- `2-SampZTest` is the hypothesis test for 2 independent means when both σ's are known
- `2-SampTTest` is the hypothesis test for 2 independent means when both σ's are unknown
- `1-PropZTest` is the hypothesis test for single proportion.
- `2-PropZTest` is the hypothesis test for 2 proportions.
- `X²-Test` is the hypothesis test for independence.
- `X²GOF-Test` is the hypothesis test for goodness-of-fit (TI-84+ only).
- `LinRegTTEST` is the hypothesis test for Linear Regression (TI-84+ only).

Note: Input the null hypothesis value in the row below "`Inpt`." For a test of a single mean, "$\mu_\varnothing$" represents the null hypothesis. For a test of a single proportion, "$p_\varnothing$" represents the null hypothesis. Enter the alternate hypothesis on the bottom row.

Appendix D Tables TCC
The modules contains links to government site tables used in statistics.

Note: When you are finished with the table link, use the back button on your browser to return here.

Tables (NIST/SEMATECH e-Handbook of Statistical Methods, http://www.itl.nist.gov/div898/handbook/, January 3, 2009)

- Student-t table
- Normal table
- Chi-Square table
- F-table
- All four tables can be accessed by going to http://www.itl.nist.gov/div898/handbook/eda/section3/eda367.htm

95% Critical Values of the Sample Correlation Coefficient Table

- 95% Critical Values of the Sample Correlation Coefficient

Note: The url for this table is http://cnx.org/content/m17098/latest/